COP27 China Pavilion Side Event: Challenges and Solutions for Energy Transition towards Carbon Neutrality

— Launch of China Energy Transformation Outlook 2023: Special Report for COP27

China’s energy transition: addressing new challenges and advancing firmly towards net-zero emissions

Wang Zhongying

Director General, Energy Research Institute of China Academy of Macroeconomic Research

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About ERI

Established in 1980, the Energy Research Institute (ERI) of China Academy of Macroeconomic Research is a national research institute affiliated with the National Development and Reform Commission and a part of the China Academy of Macroeconomic Research (AMR), which was accredited as one of the top 25 National High-level Think Tanks in 2015.

Focusing on energy policy research, ERI provides technical supports to the decision-making in national-level energy development, as well as consultancy to local authorities, industries, domestic and international organisations.

ERI's research covers the fields of energy transition strategies, energy economics, energy system analysis and outlooks, energy security, renewable energy, energy efficiency, energy environment and climate change, sustainable development and international energy cooperation.

About China Energy Transformation Program (CET)

Implementing Unit

中国宏观经济研究院
能源研究所
Energy Research Institute of Chinese Academy of Macroeconomic Research

Financial Support

CIFF CHILDREN'S INVESTMENT FUND FOUNDATION

MINISTRY OF FOREIGN AFFAIRS OF DENMARK

Technical Support

Danish Energy Agency

Ea Energy Analyses

COLUMBIA | SIPA
Center on Global Energy Policy

Norad

“China will scale up its Intended Nationally Determined Contributions by adopting more vigorous policies and measures. We aim to have CO2 emissions peak ***before 2030*** *and achieve carbon neutrality* ***before 2060****.”*

—— President Xi Jinping

The 75th session of the United Nations General Assembly

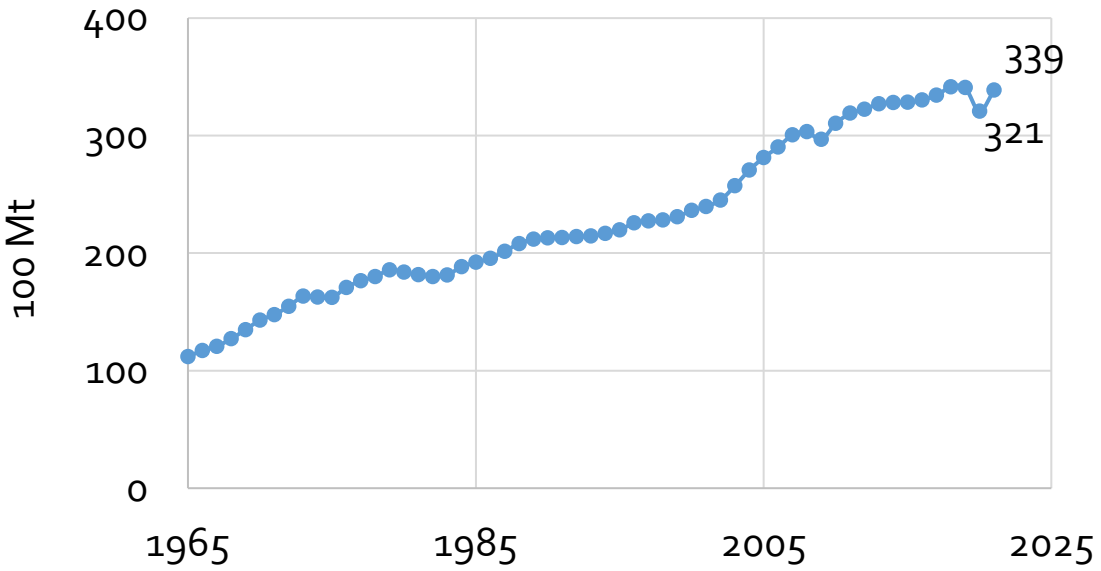
22 September 2020

Outline

1. New global challenges in addressing climate change and energy transition
2. China’s efforts to advance energy transition in providing strong support to carbon peaking and carbon neutrality goals
3. Achievements and trends of energy transition in major regions of China
4. Key conclusions from the energy sector outlook towards carbon neutrality

Energy security concerns arise together with the urgency for net-zero transition

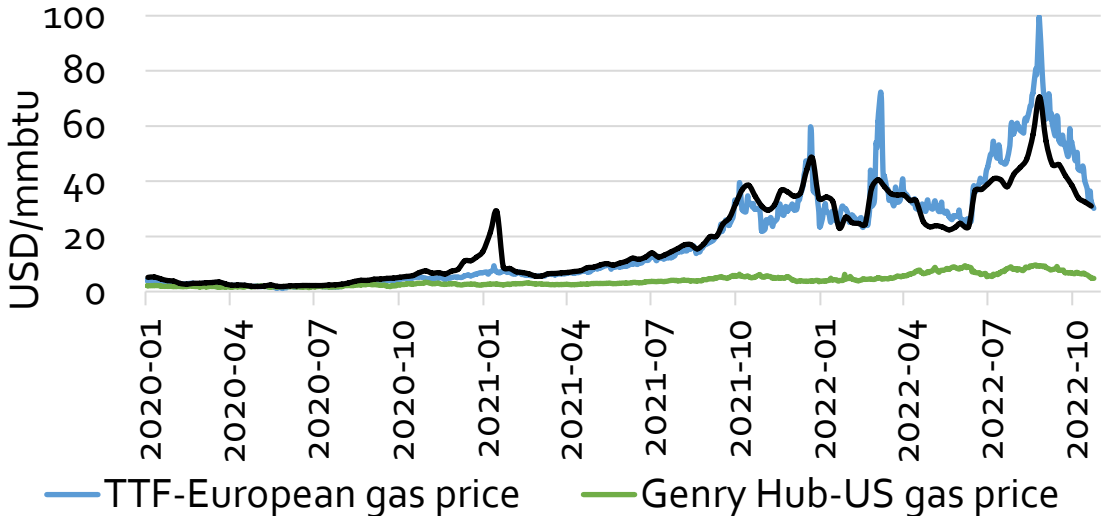
- **The deteriorating global climate change situation coincides with increasing fluctuations in CO_2 emissions.**



Global CO_2 emissions from energy sector

IPCC AR6: according to the NDCs submitted by various countries, the global temperature rise may reach 2.8 ℃ by the end of this century.

- **Geopolitics aggravates the imbalance between energy supply and demand, which adds to the challenges facing energy transition.**



Natural gas prices in the U.S., Europe and Asia

Short-term factors: COVID-19, Ukrainian crisis
Mid-term factors: low-carbon transition, rising investment and financing costs
Long-term factors: needs of withdraw from fossil fuels and develop carbon-neutral energy systems

The disruptions strengthen the consensus on carbon neutrality and alerts the needs for energy system resilience

Natural characteristics of renewables:

- Intermittence and volatility

Impacts on industrial and supply chain:

- Improve capacity of reserve

Improving **energy system resilience** becomes a top priority:

- Improve the energy storage capacity, peak shaving capacity and demand side flexibility of power grid and heating network
- Safeguard national energy security and stable operation of the economy and society

EU

- Total installed wind and solar PV power capacity:
  - **doubled** by 2025
  - **tripled** by 2030
- Annual biogas production reaches 35 billion cm by 2030
- Hydrogen replaces 25~50 billion cm of natural gas

Germany

- **Advance** the carbon neutrality goal from 2050 to 2045
- **Advance** the coal phase-out goal from 2038 to 2030
- Increase the share of renewables in total annual power generation to **80%** by 2030

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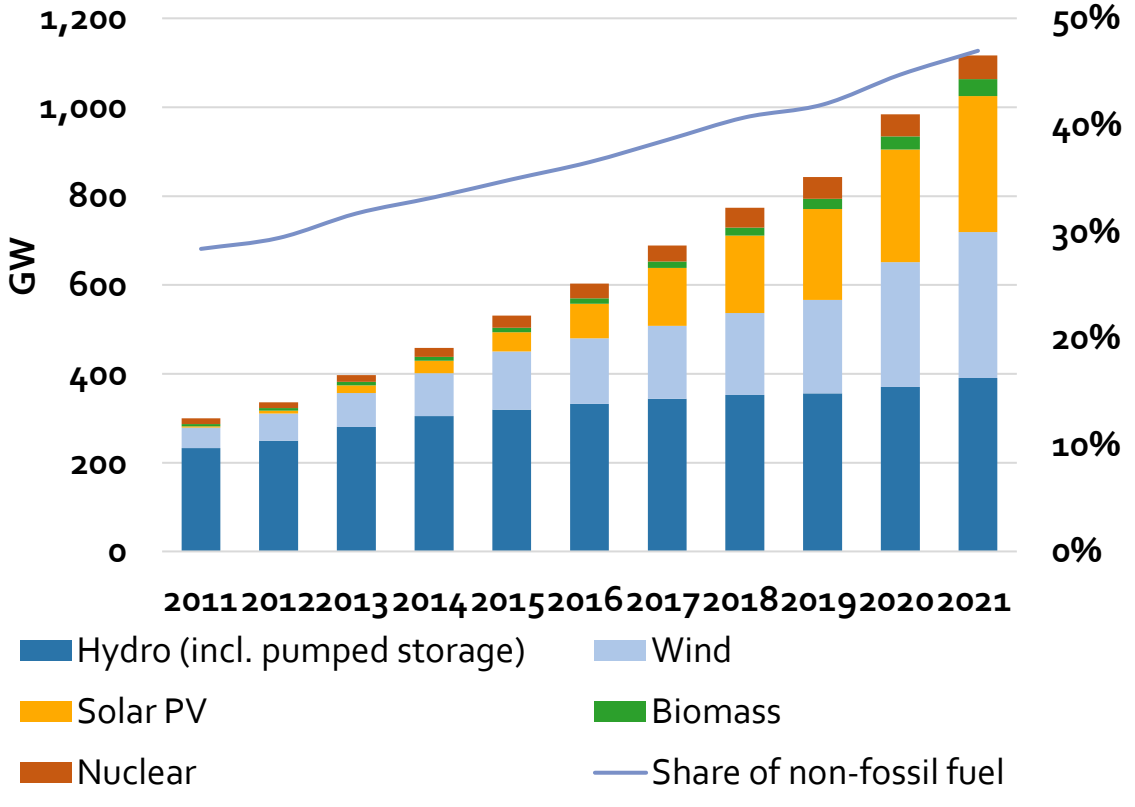
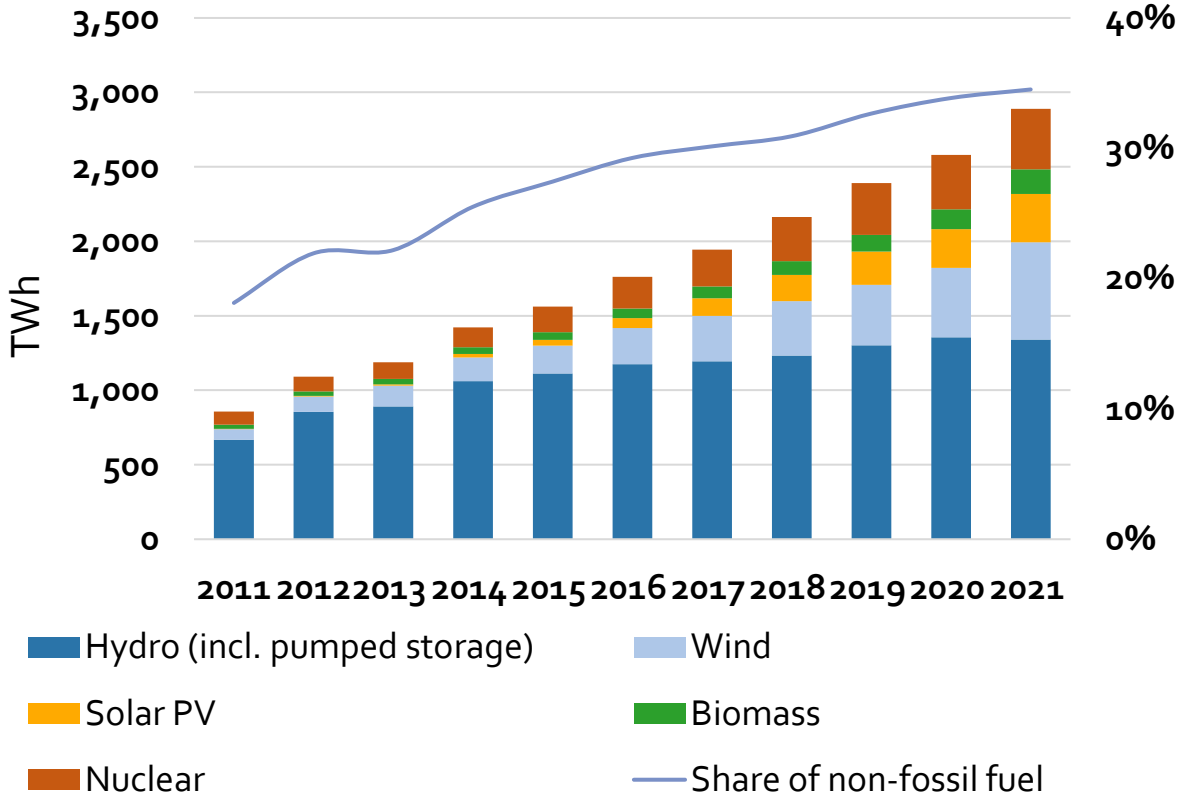
China's steady efforts on energy transition have provided strong support for the "before-30" and "before-60" goals



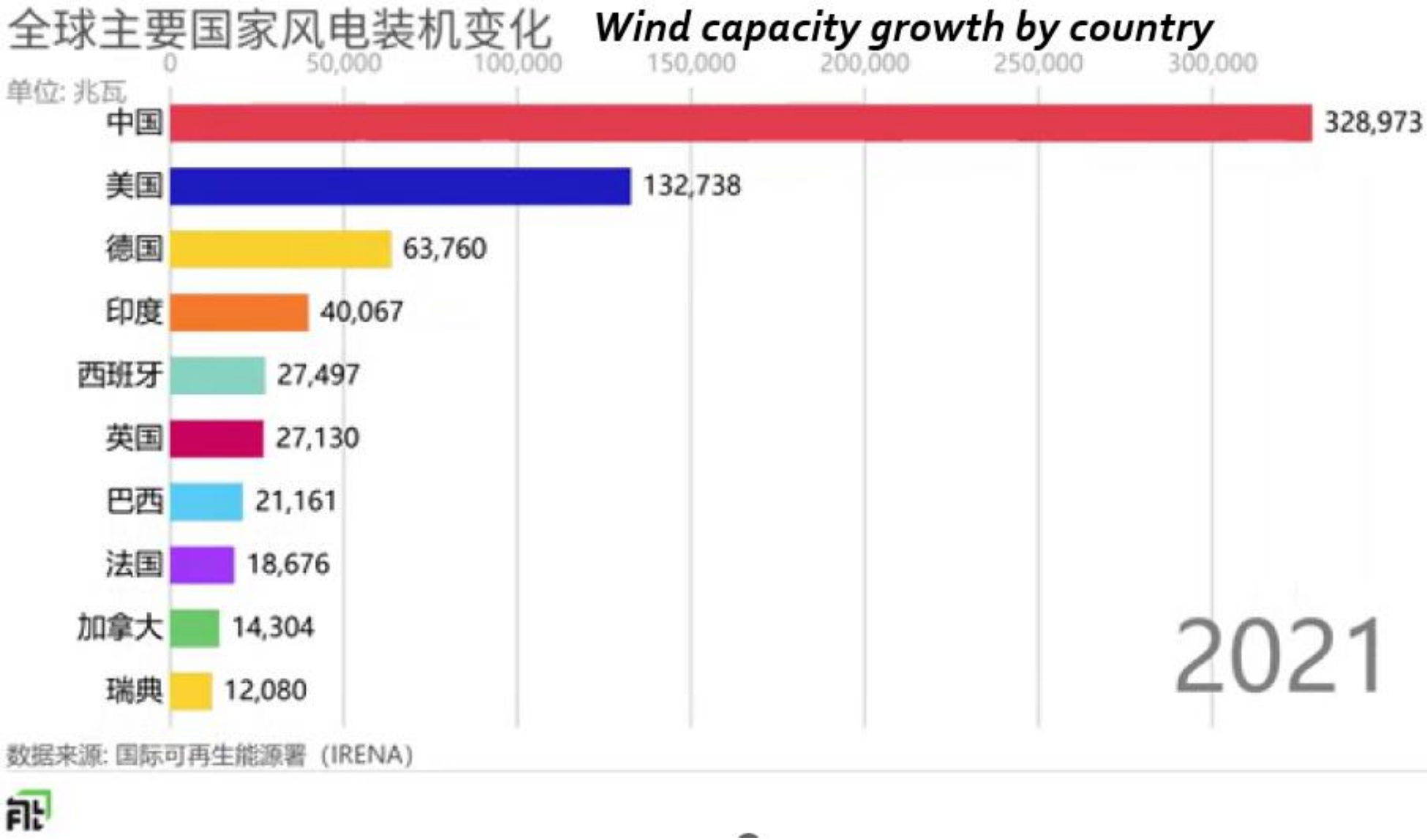
Installed power capacity and share of renewables



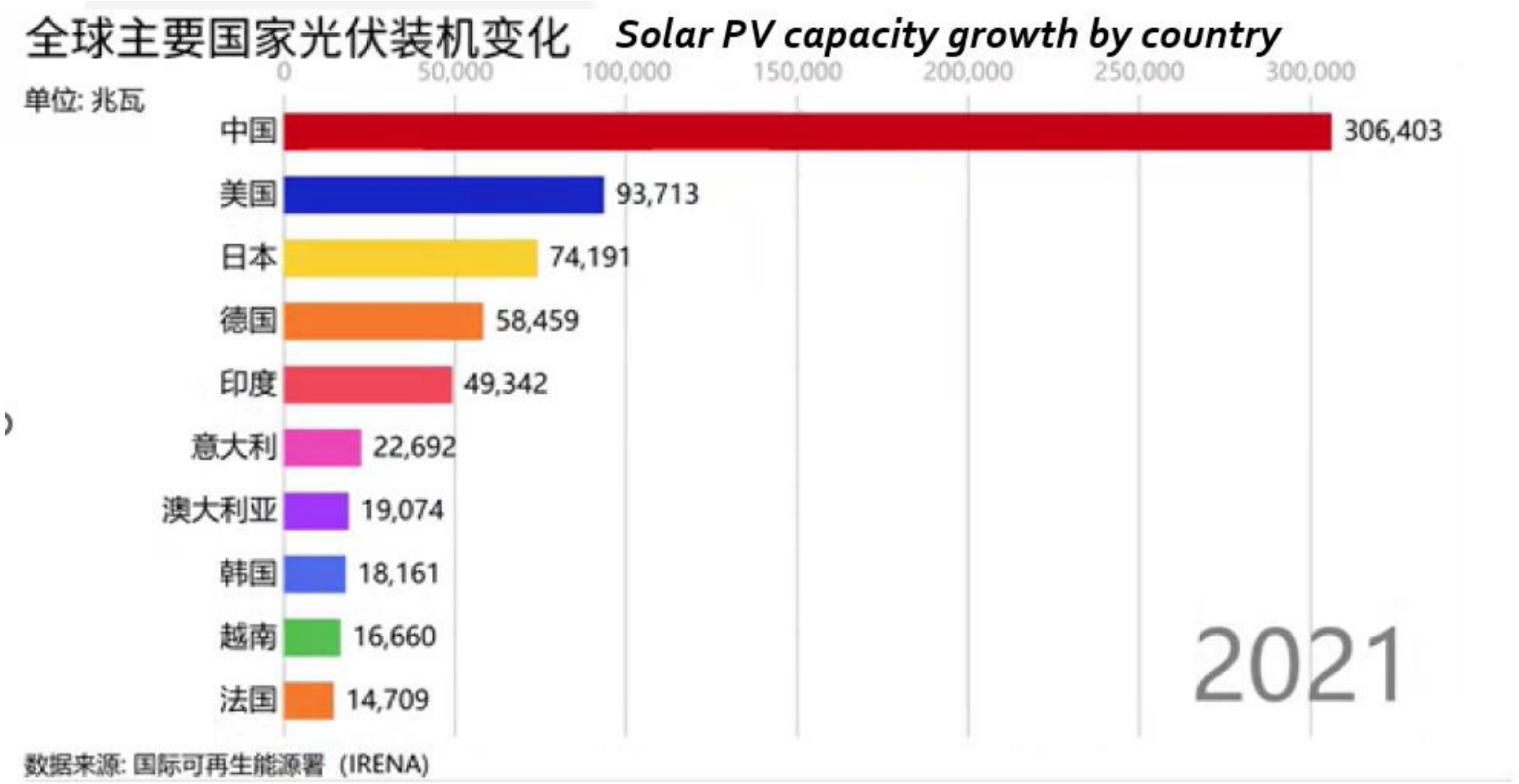
Electricity generation and share of non-fossil fuels

- **Intensified efforts in clean energy development have helped creating a new pattern of energy development.**

Leapfrog development of renewables: wind



Leapfrog development of renewables: solar PV



Promote coal and coal power transition

- **Green and low-carbon transformation of coal and coal power while safeguarding energy security, upholding economic stability and benefiting people's livelihoods.**

Coal power green and low-carbon transition

- The share of installed capacity of coal-fired power decreased to 46.7%
- The installed capacity of coal-fired power units with ultra-low emission limits accounts for about 93.0% of the national total
- The share of coal-fired power in total power generation continued to drop to 60%

Clean and efficient coal consumption structure

- Decreased coal consumption in non-power sectors: electricity, steel, chemical industry and building materials accounted for 93% of the total coal consumption in the whole society
- Increased share of coal-used in the power sector: coal-used for power generation accounts for more than 90% of incremental coal consumption

Development of a modern energy system with technology innovation

Enhancing flexibilities and accelerating development of a modern energy system

The new-type energy storage has entered the early commercialized stage with market scale has steadily expanded

- Installed capacity of new energy storage >4 GW
- Emerging diversified application scenarios
- Initially established policy system and market mechanism of new energy storage

The 14th 5-Year Plan for a Modern Energy System

- Enhance the security and stability of **energy supply chain**
- Promote green and low-carbon transformation of **energy production and consumption models**
- Modernization of **energy industry chain**

Energy efficiency continues to improve, benefiting from low-carbon technology innovation at an accelerated pace

- Total energy consumption increased by 5.2%
- Energy intensity decreased by 2.7% compared with 2020
- Energy consumption per unit added value of industry above designated size decreased by 5.6% compared with the previous year
- Unit energy consumption of key energy-consuming industrial enterprises decreased

Buildings

- **Green building area** exceeded 8.5 billion m2
- New **green buildings** in cities and towns accounted for **84%** of the new building area
- **Ultra-low energy consumption, near-zero energy consumption building** area is nearly **10 million m2**

Transport

- 10 million **new energy vehicles**, 8.1 million **EVs**, and 466,100 **new energy buses**

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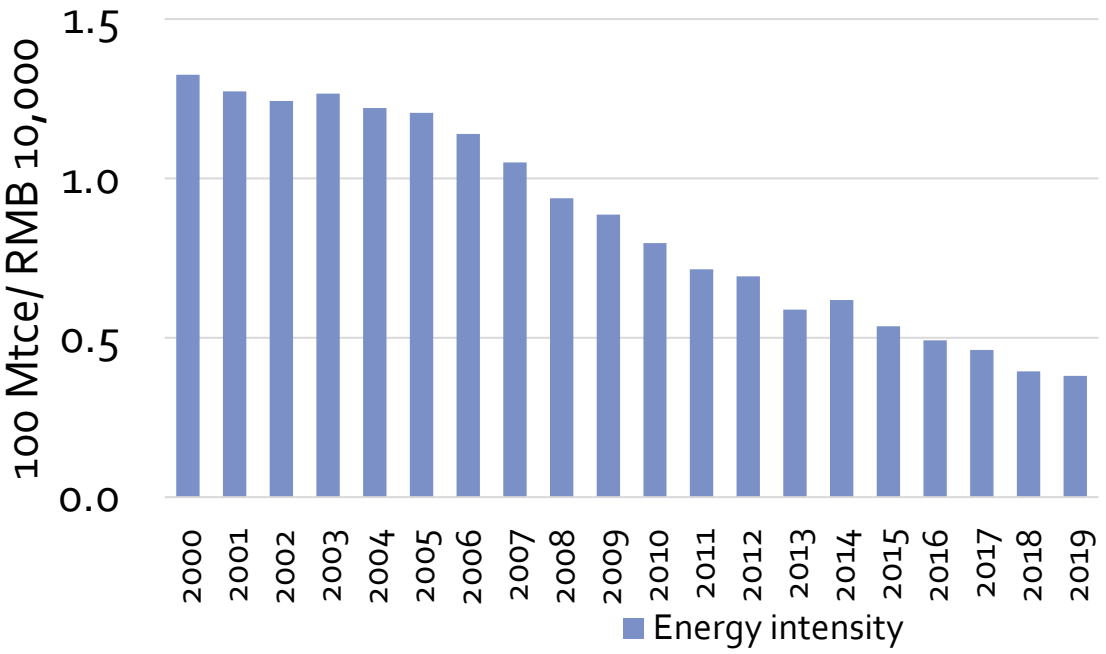
Achievements and Trends of Energy Transition in Major Regions of China

The Region of the Yangtze River Economic Belt

- Gradually improve the policy system for the overall protection and development of the basin
- Successful industrial transformation and continuously declined energy intensity
- The achievements of super-size hydropower stations have attracted worldwide attention



Energy intensity of the Yangtze River Economic Belt

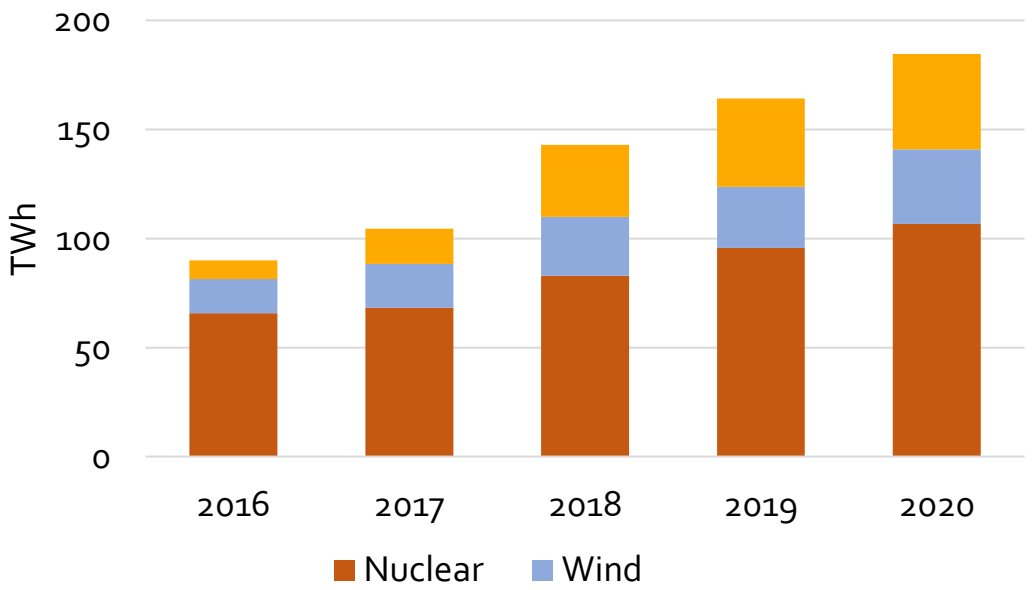
The Region of Yellow River Basin

- Governing coal mining subsidence areas with solar PV development
- Solar PV and wind power bases in the desert and gobi desert
- Clean heating in the region of the Yangtze River, Yellow River, and Lancang River
- The multi-energy complementary base of hydro-wind-solar power in Qinghai
- Shandong's solar PV installed capacity ranks first in China

Achievements and Trends of Energy Transition in Major Regions of China

The Region of the Yangtze River Delta

- Leading development of distributed renewables
- Create a sample of cross-regional integrated low-carbon development
- New energy industry has become the "green engine" of economic development



Low-carbon power generation in the Yangtze River Delta region

The Region of Beijing-Tianjin-Hebei

Multiple measures to jointly control air pollution

- ***Beijing-Tianjin-Hebei Coordinated Energy Development Plan (2016-2025)*** was proposed
- Tianjin-Hebei region took the lead in establishing an **ecological environment monitoring system and database, and joint law enforcement of environmental protection**

Accelerating replacing coal with new energy

During the "13 5-Year Plan" period, **the proportion of coal in energy consumption in Beijing** decreased from 13.7% to **1.9%**

- **Beijing** is basically "**coalless**", **Tianjin's** heating loose coal (*sanmei*) is **basically cleared,** and **Hebei**'s rural areas' heating loose coal is **basically cleared**

Market mechanisms for clean energy consumption

Beijing-Tianjin-Hebei Green Power Market Trading Rules and the supporting implementation rules of prior power dispatch

Achievements and Trends of Energy Transition in Major Regions of China

- **The Region of Guangdong-Hong Kong-Macao Greater Bay Area**

Take the lead in proposing carbon peaking at the city level

Guangzhou, Shenzhen and Zhongshan are **leading** in carbon peaking goals

Industrial structure optimization to guide low-carbon development of cities

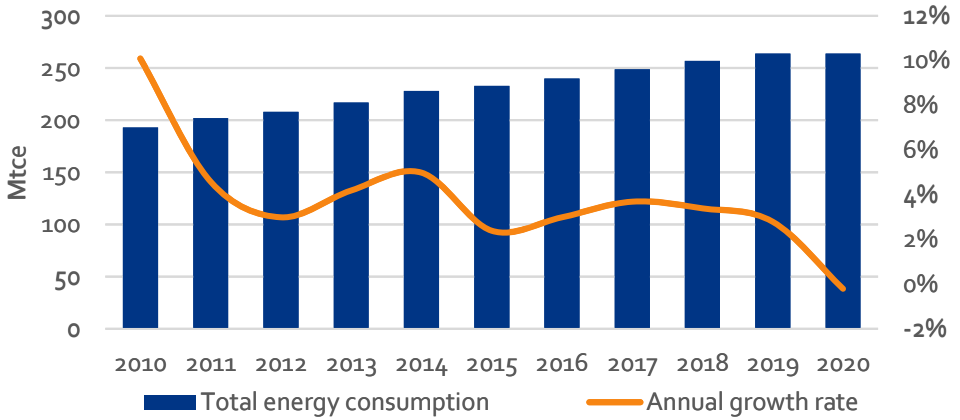
Development of **service-oriented economy** has reached a certain scale

Regional collaboration to help clean energy use in the Greater Bay Area

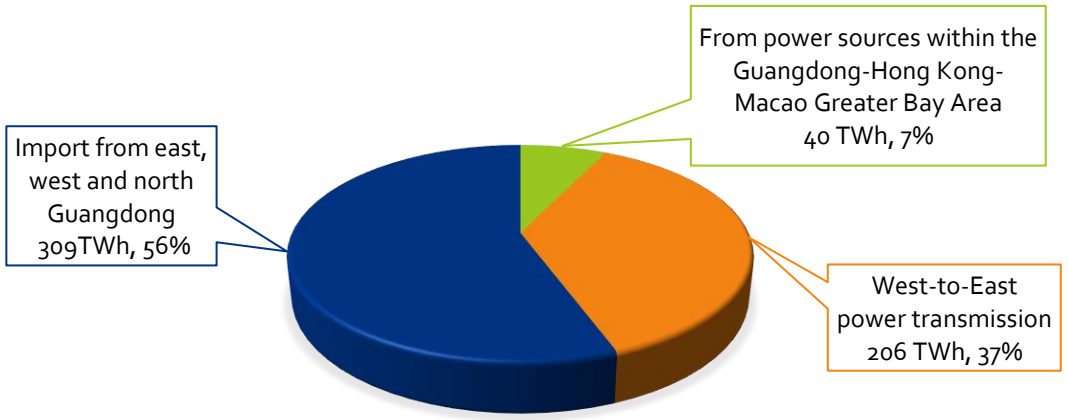
Greater Bay Area's **clean energy** supply accounts for more than 60%

Offshore wind grows rapidly

Grid-connected capacity of offshore wind power in Guangdong reached 1.01 GW, **up 257% year-on-year**.



Total energy consumption and growth rate of Guangdong-Hong Kong-Macao Greater Bay Area from 2010 to 2020



The proportion of electricity supply in the Guangdong-Hong Kong-Macao Greater Bay Area in 2020

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Two technology roadmaps for China to achieve carbon neutrality

- **Baseline Scenario (BLS):** Deduces future energy development trends based on the current development of the energy sector, combined with recent internal and external environments and risks.
- **Carbon Neutrality Scenario 1 (CNS1):** The annual full load hours of the active coal-fired power units should be gradually reduced, implementing natural decommissioning measures, with the last coal-fired power unit running until around 2055; moderately deploy the negative carbon technologies in the medium and long term, with the development of new energy storage technologies, electric vehicles, V2G, green hydrogen and other emerging technologies. The energy sector can achieve net-zero emissions around 2055.
- **Carbon Neutrality Scenario 2 (CNS2):** Accelerate the development of new energy with greater efforts, especially the development of wind power and solar PV, and accelerate the replacement of existing coal power. The commercial application of new energy storage technologies, electric vehicles, V2G, green hydrogen and other new technologies expands at a faster rate, with more powerful supporting measures for new business models and development modes to achieve energy sector net-zero emissions before 2055.

China's energy transformation is driven by the need to ensure a clean, carbon-neutral, safe, and efficient energy system

Clean	Not pollute the air, water and soil
Safe	Ensure energy supply security
Efficient	Efficient use of energy while ensuring cost-effective energy supply

Similarities of the two CNS scenarios

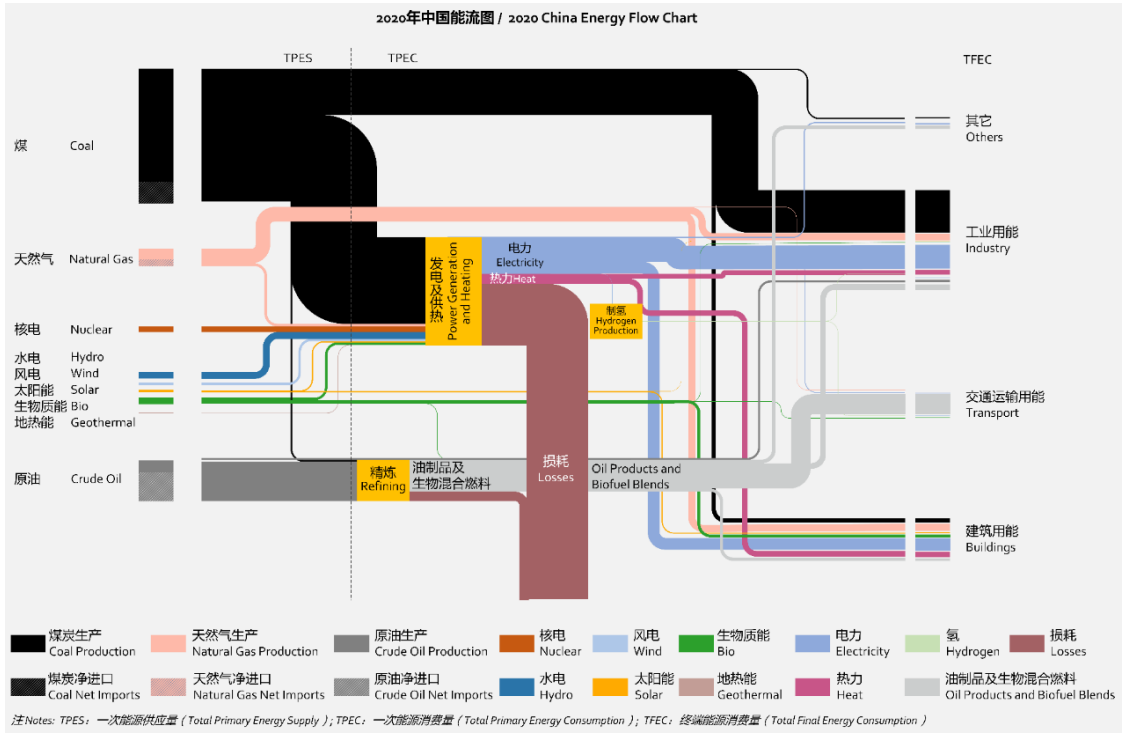
- Ensure China's energy emissions peak by 2030 and then gradually decline.

Differences between the two CNS scenarios

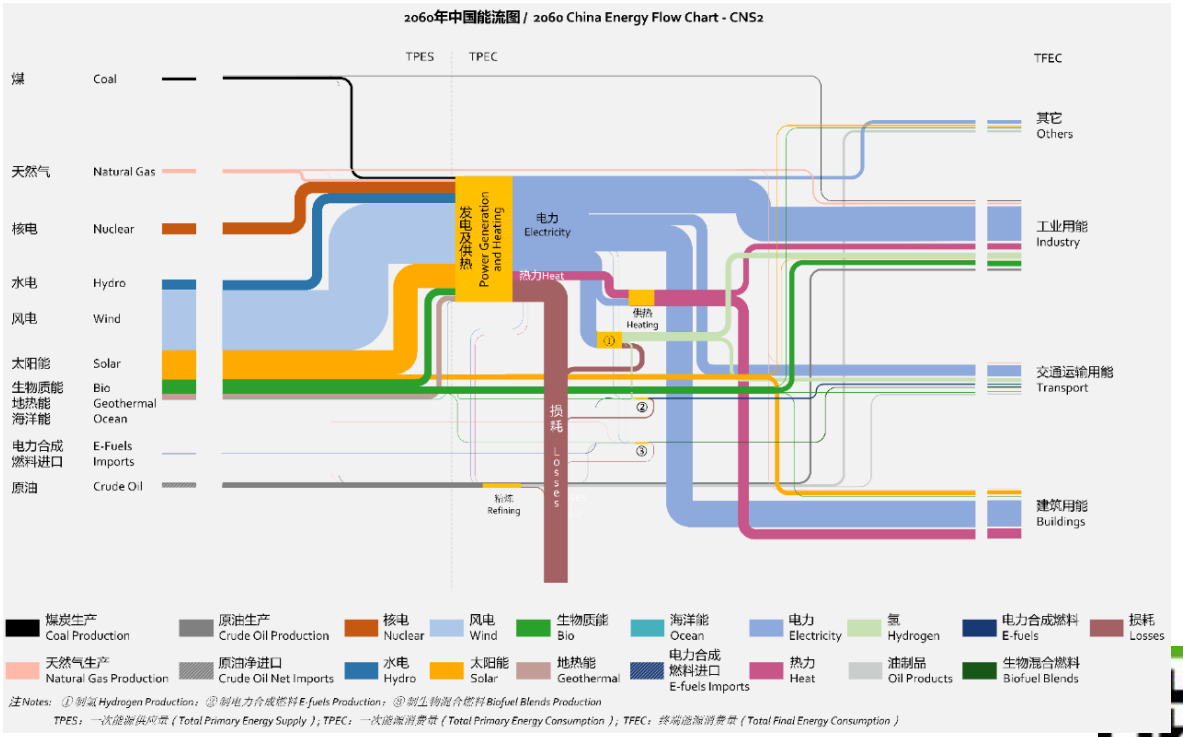
- In CNS2, net-zero emissions in the energy system is achieved before 2055.

Energy efficiency, electrification and green power supply are the main transformation elements

- **Support economic growth:** GDP in 2060 reaches about four times that in 2020.
- **Improve energy efficiency:** total final energy consumption in 2060 is lower than that in 2020.
- **Withdraw fossil energy:** in 2060, the share of non-fossil energy reaches over 95%, of which renewable energy accounts for over 90%.
- **Popularize electricity and hydrogen:** the share of electric and hydrogen energy in buildings, industry and transportation sectors reaches 80% ~ 100%.



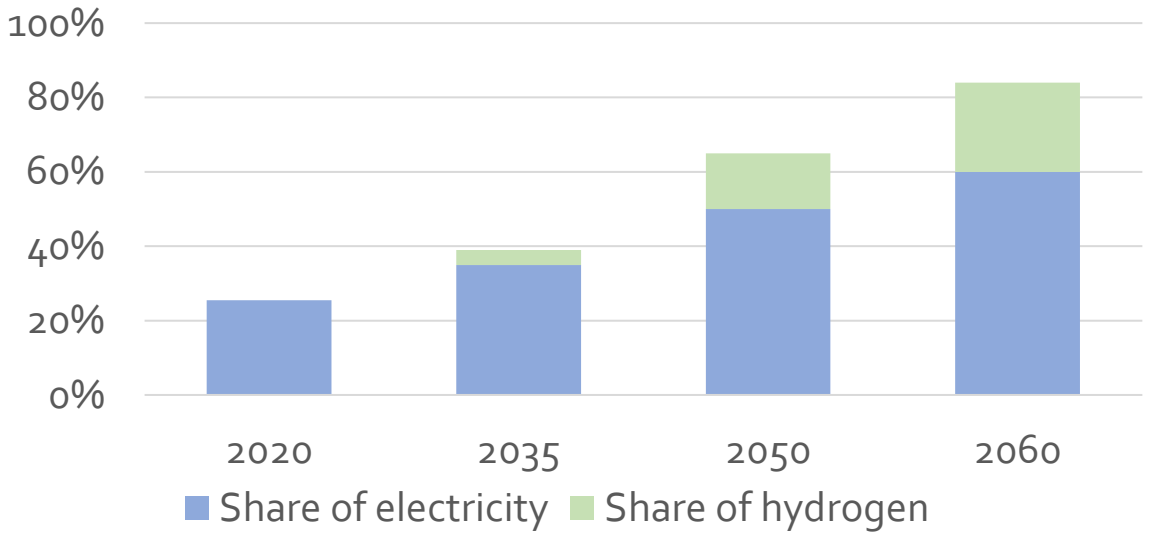
2020 China Energy Flow Chart



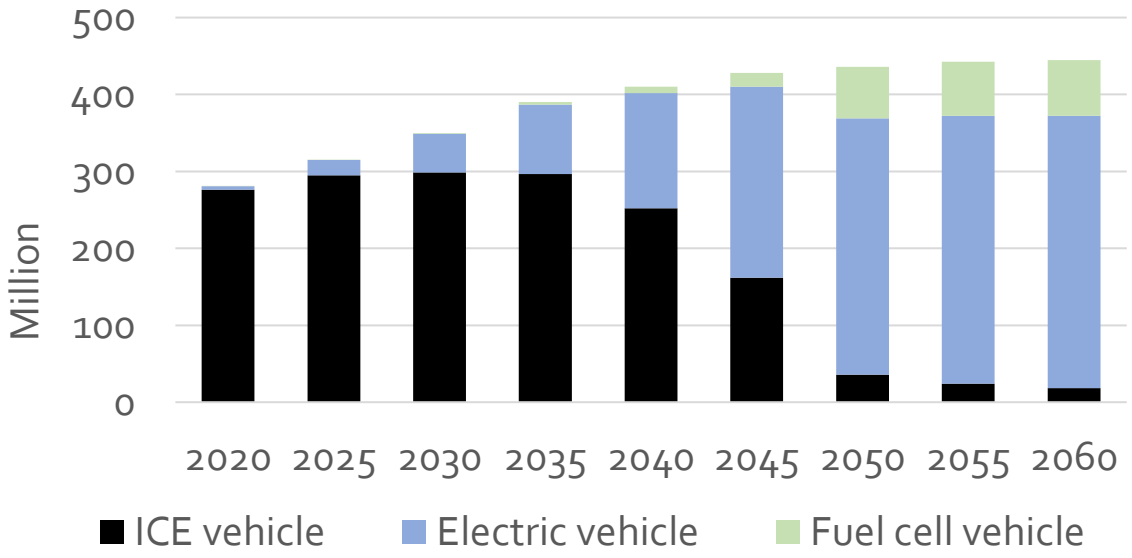
2060 China Energy Flow Chart – CNS2

Electrification and green hydrogen help to achieve decarbonised end-use mix

- In CNSs, the end-use energy structure is continuously optimized, the proportion of electricity and hydrogen used in buildings, industry, transportation and other sectors is gradually increased.
- In 2060, the electrification rate of the **building sector** is around 85-90%.
- In CNS2, resulting from the significant energy efficiency improvements, new technology introductions, equipment upgrading and the large-scale application of electricity and green hydrogen, the **industrial sector** accounts for less than 50% of the total final energy consumption by 2060.
- **Transportation sector:** almost all passenger cars are EVs or hydrogen fuel cells vehicles by 2060.



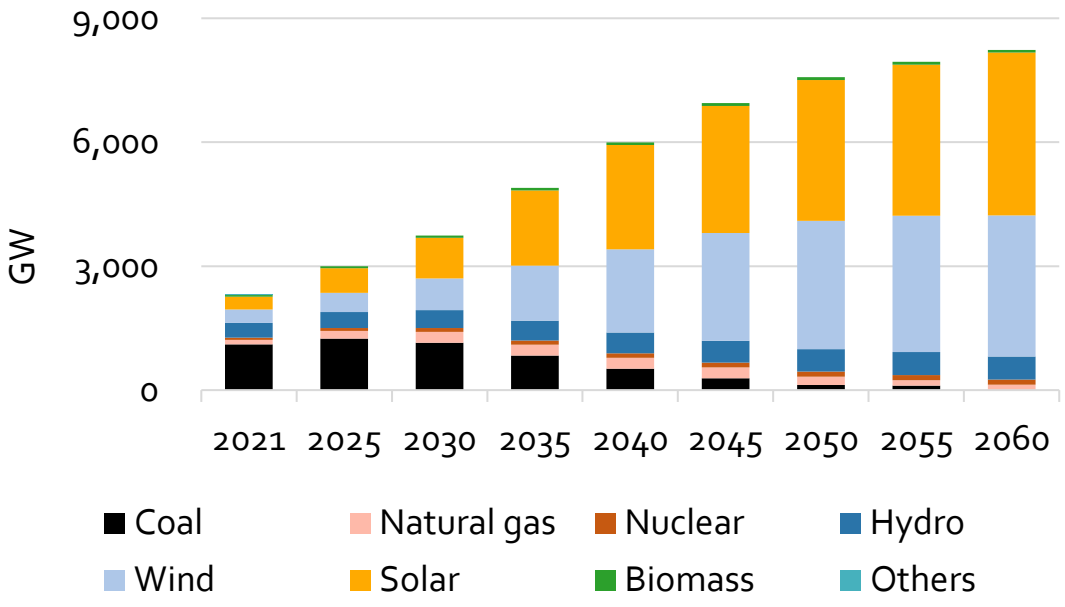
Share of electricity and hydrogen in industrial end-use energy demand in CNS2



China's vehicle ownership and fuel mix in CNS2

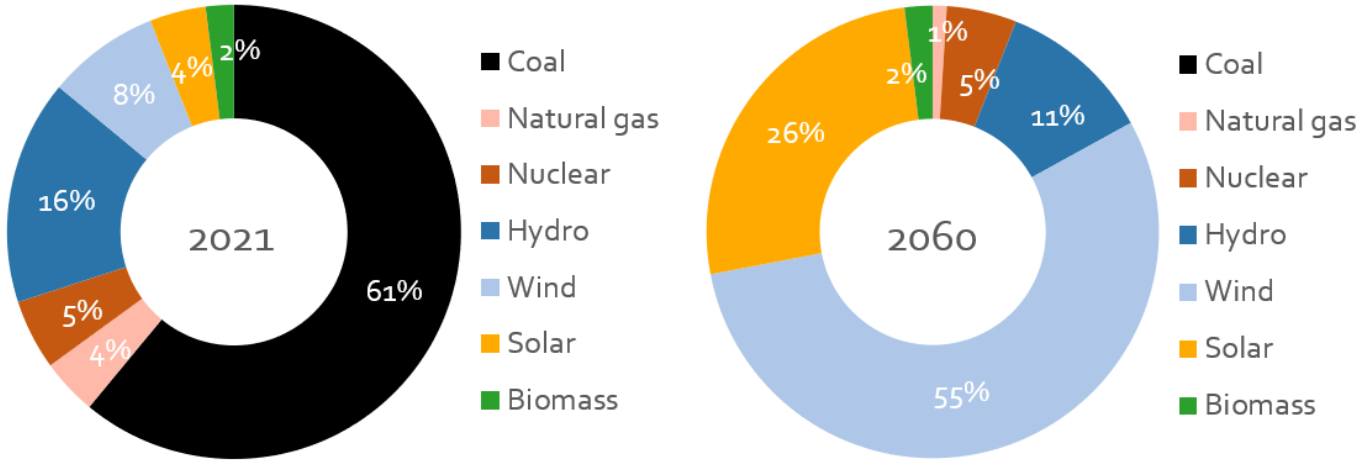
Wind and solar power becomes the dominate source of the power sector

- China's installed power capacity continues to grow, resulting from the electrification of the end-use sectors. In 2060: installed capacity is more than 8000 GW.
- Wind and solar power gradually becomes the backbone of the energy system.



Installed power capacity in CNS2

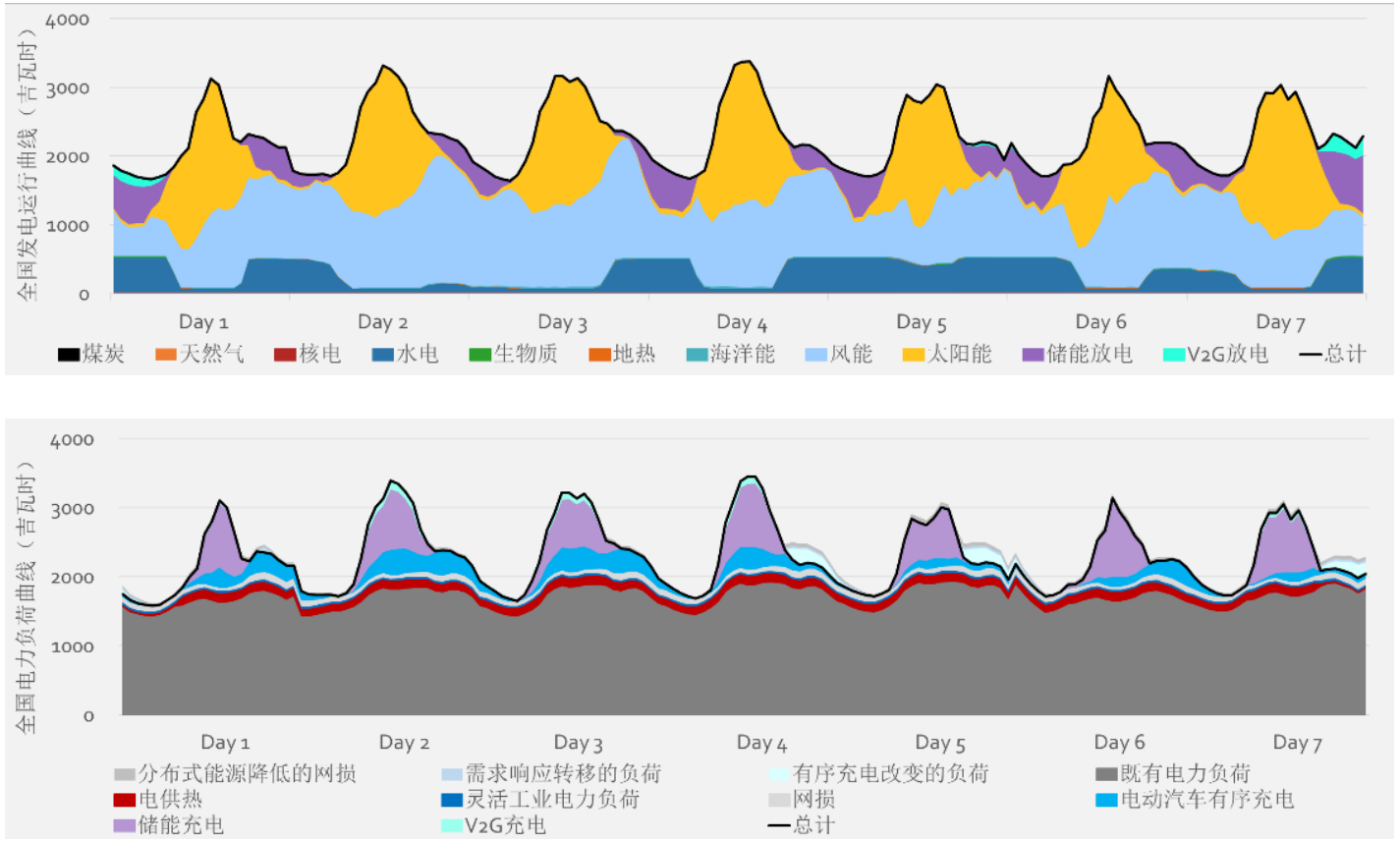
- The share of **renewable power generation** reaches >**50%** by 2035.
- With the accelerated retirement of coal power, the share rises further to >**90%** of the power generation by 2060.



Power generation mix in CNS2

Flexibilities are important for the new-type power system

- **Pumped-hydro and new-type energy storage are main guarantees of stable operation of the new-type power systems in the long term.**
  - In a new power system dominated by new energy sources, the share of coal-fired power generation is significantly reduced, and flexible resources on the power supply side, grid side and customer side are needed on a large scale.
  - With a high share of solar generation and low electricity prices in the midday, to take advantage of low valley electricity prices to charge or use electricity. When electricity prices rise in the evening when peak usage occurs, discharge into the system and generate revenues by providing ancillary services.



Hourly power balance in China's power system for 2060 summer in the CNS2

Market reforms are essential drivers to enable energy transformation

Well-functioning electricity markets

- Spot market, ancillary service market and capacity market
- Long-term electricity purchase agreement

Efficient carbon markets

- Reasonable carbon prices are a powerful driving force for energy transformation, especially for the power sector and the industrial sector

Wrap-up

- **Energy efficiency** improvement on the demand side is needed to ensure that the pace of supply-side deployments can keep up and sustain economic growth.
- Green energy supply – mainly through **renewable electricity**, and **green heating** expands to replace fossil-fuel heating.
- **Electrification supports switching away from fossil fuels in industry**, transport and building sectors, in conjunction with the **decarbonisation of the electricity supply**.
- **Hydrogen** becomes an important energy carrier to allow for the creation of **fuels for hard-abate sectors** such as heavy transport, shipping, and aviation in combined with captured carbon.
- **CCS** creates the **last option**.
- Drivers for transformational change are needed, **including power markets, carbon markets, long-term planning, concrete innovation and implementation strategies**, and cooperation across stakeholders, locally, nationally and internationally.
- In the CNS1 scenario, net-zero carbon emissions of energy system are achieved around 2055. In the CNS2 scenario, net-zero carbon emissions of energy system are achieved before 2055.

Thank you.

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